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**DEFENSE LOGISTICS AGENCY (DLA)
CUSTOMER DRIVEN UNIFORM MANUFACTURE I
(CDUM I) PROGRAM**

CDUM WRAP-UP REPORT



Final Report
January 7, 2010

AdvanTech, Inc.
PDIT, Inc. DBA Modulant
Logistics Management Institute
Human Solutions of North America

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1.0 Background - Apparel Research Network (ARN) and Customer Driven Uniform Manufacture (CDUM)

The ARN program began as an R&D program in 1994 by focusing on clothing and textiles manufacturing methods and equipment. In 1997, the focus shifted to supply chain visibility for 1) developing a strategy to capture existing supply chain visibility data from SAMMS; and 2) on supplementing that data with additional data from C&T manufacturers and an initial retail site, i.e., the Marine Corps' Recruit Training Center (RTC) in San Diego. An analysis of the processes found the following AS-IS conditions.

| Condition AS-IS | Result |
|---|--|
| Documents were manually created from paper documents or from electronic images of paper documents. | <ul style="list-style-type: none"> • Manual and redundant data entry • Excessive error rates • Inconsistencies between agencies • Lack of asset visibility • Lack of control • Stock-outs • Poor service levels • Excess inventories |
| DLA, DCMA, and DFAS worked with their own systems from mailed or faxed paper and manually re-entered the data into their systems. | |
| Inventory transactions were communicated and manually entered as 80-column card images. | |
| DSCP C&T maintained visibility by keeping spreadsheets or manual files extracted from paper documents and phone calls. | |

In 2002 as the ARN systems made the transition from an R&D program to a production sustaining program. At that time the CDUM program was initiated to continue the R&D effort. The major components of the ARN system include:

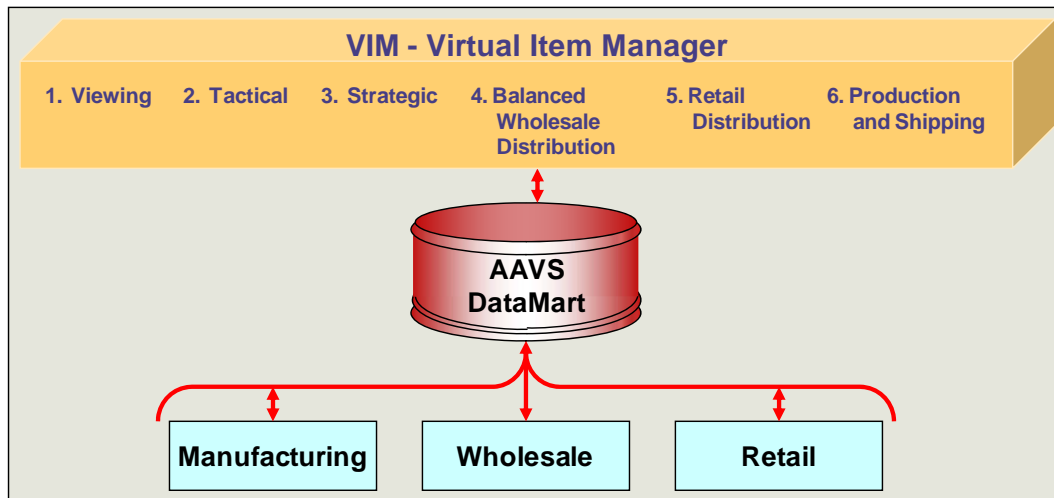


Figure 1.1: ARN Architecture

- A. **VIM:** The concept of the Virtual Item Manager (VIM) was identified during the early days of the program to provide supply chain visibility for all participants, i.e., DSCP C&T, manufacturers, and RTC personnel.
- B. **AAVS DataMart:** During the first few years after 1997, the need for asset visibility resulted in the initial development of the ARN Asset Visibility System called the AAVS DataMart that contains total supply chain visibility data. The AAVS DataMart took form over many years as new data was acquired and developed for and by ARN's wholesale, retail, and manufacturing systems (see Figure 1.2).

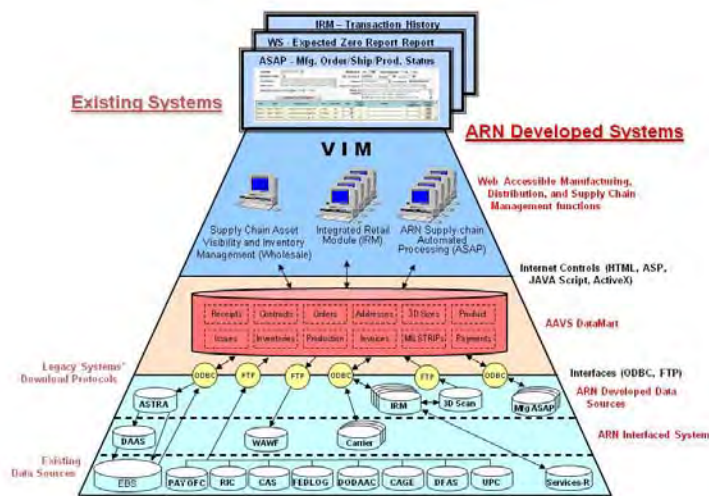


Figure 1.2: AAVS DataMart and Data Sources

- C. **IRM:** The Integrated Retail Module (IRM) was developed then implemented at San Diego’s RTC in 1998. IRM successfully achieved its three primary goals of 1) improving visibility for San Diego and DSCP C&T personnel; 2) converting budget drive reordering to a smoother replenishment ordering process; and 3) improving data quality through the elimination of manual data entry. As with all ARN developed systems, IRM was able to eliminate manual data entry by pre-populating virtually all data from the contract, requisition, and inventory data available in the AAVS DataMart. The achievement of these goals resulted in significantly reduced inventory levels and shortages. Over the next few years, IRM’s usage was extended to most of the other RTCs. As an example of IRM’s impact, the Marine Corps’ RTCs in San Diego and Parris Island were able to reduce their retail inventory by \$10.2 M. The DSCP de-capitalized service-held inventory for a total of \$24.1M.
- D. **VIM-ASAP:** The Virtual Item Manager-ARN Supply chain Automated Processing (VIM-ASAP) was implemented in May of 2000 to prepare DD250s and related documents using pre-populated data from DSCP C&T’s contracts. Timely and accurate shipment data provides visibility for DSCP C&T personnel while it eliminated late payments by working with WAWF to provide DFAS with a 100% consistent set of matching data since invoice, acceptance, and contract data all come from a single source. In 2002 VIM-ASAP transitioned to production with the rest of the ARN system. Since that time, 511 C&T vendors have made 230,991 shipments using VIM-ASAP. During a twelve month period (September 1, 2008 to August 30, 2009), VIM-ASAP was responsible for 42,959 shipments from 328 vendors sites for a total shipment value of \$2,074,044,934.

The benefits of the ARN implementations have been achieved by the following:

| TO-BE Condition | |
|-----------------|--|
| • | Centralized DataMart at DSCP for total supply chain asset visibility |
| • | Standardized processes and documentation throughout the supply chain |
| • | Inventory management software for recruit training centers (RTC) |
| • | Virtual Item Manager (VIM) for decision support at DSCP C&T |
| • | Electronic document management for manufacturers |
| • | Use of the 3D whole body scan database for accurate demand data |

The ARN Program demonstrated the following savings:

| | |
|--|---------|
| Retail savings at the Army and Marine Corps recruit training centers | \$34.3M |
| Wholesale savings on Army and Marine items | \$70.9M |
| Return on Investment – 3.07 | |

2.0 Executive Summary

The ARN program transitioned to production in 2002 and the CDUM program continued the R&D initiatives. The focus of the CDUM program was on two areas: 1) Transition of new functionality to the ARN production system; and 2) Expanded R&D demonstrations at pilot sites. The overall objective of the program was to demonstrate advanced technology for the end-to-end supply chain management of hard-to-procure hard-to-manage items of the non-recruit clothing supply chain, specifically clothing and individual equipment. The new R&D demonstrations built on the initial foundation of the ARN program. Some of the CDUM pilots have made the transition to production and are now part of ARN. Others are still part of the CDUM R&D pilots and will only make the transition to ARN after they are fully operational and proven successes.

2.1 CDUM Pilots That Were Transitioned to ARN

In 2002 the ARN program and systems successfully transitioned to production, replacing the legacy systems at the RTCs, and became a DSCP C&T funded, sustaining effort. Once in production these systems provided the foundation for further research and development leading to supply chain innovations and improvements under the new CDUM program. CDUM built on the success of the ARN program by continuing to improve the military clothing supply chain with a focus on non-recruit clothing and equipment initiatives. From 2002 to 2009, the following CDUM R&D projects became part of the ARN production system after the pilots proved to be successful.

- A. [Source Data Interface](#): The AAVS DataMart was upgraded to interface with the C&T Data Warehouse after EBS replaced SAMMS.
- B. [DAASC Requisition Data Backup](#): Direct access to DAASC is an alternate source for EBS requisition data.
- C. [WAWF Interface](#): VIM-ASAP was expanded to provide WAWF with invoice and acceptance data.
- D. [RFID](#): VIM-ASAP was expanded to support case and pallet level RFID tagging as required by MIL-STD-129P.
- E. [IRM & KYLOC Integration](#): IRM was integrated with the systems used by the Kentucky Logistics Operation Center (KYLOC) to support asset visibility, receiving, shipping, inventory management, and kitting.
- F. [IRM & CIF-ISM Integration](#): IRM was integrated with the system used at Fort Carson (i.e., Central Issue Facility-Installation Support Modules (CIF-ISM)) to more effectively manage Clothing and Individual Equipment (CIE).

2.2 CDUM Tasks

CDUM's R&D tasks were built on ARN's successful foundation of data integration, data pre-population, asset visibility, and joint working relationships between DSCP C&T, its manufacturers, and its customers to extend CDUM's focus to:

- A. [3D Whole Body & Foot Scanners](#): Scanners were used at Lackland AFB to more accurately predict recruit sizes. They are also being used Army Ft. Carson CIF to size non-recruit clothing to expedite the issuing of CIE to the Warfighters.
- B. [RFID Item Tagging at Lackland](#): The initial testing of the effective use of item level RFID tagging and scanning is done by recruits at Lackland AFB to improve the accuracy of the contents of each recruit's duffle bag.
- C. [RFID Receipt Processing at Lackland](#): An RFID portal is being used to improve RDO receipt processing and transaction generation at Lackland AFB of shipments from Travis' 3PL.

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- D. **RFID Receipt Processing at Travis' 3PL:** An RFID portal is being used to improve DD250 receipt processing and transaction generation at Travis' 3PL. Bar code scanners are being used to receipt MROs, RDOs, and DD250s without RFID tags.
- E. **RFID Item Tagging by Manufacturers:** Two manufacturers (i.e., Warmkraft and Propper) were selected for pilots on applying item level RFID tags at manufacturer's facilities as part of the shipping and DD250 processes.

2.3 ARN and CDUM Timeline

The timeline in Figure 2.1 shows the timing of the ARN and CDUM pilots and which system components have been implemented as ARN production systems and those that remain CDUM R&D pilots.

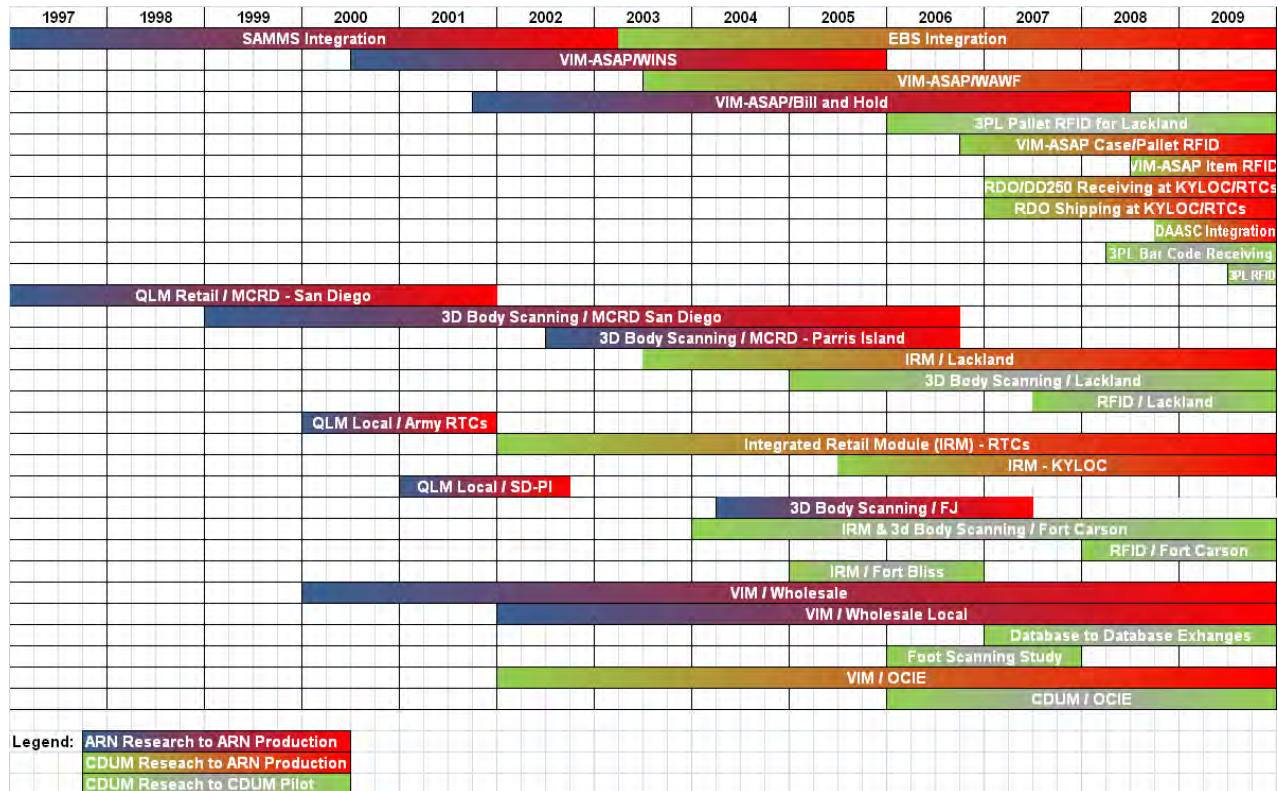


Figure 2.1: ARN & CDUM Timeline

2.4 Conditions before CDUM

| AS-IS Condition | Result |
|--|---|
| Recruit and non-recruit CIE receipts and stock movements at the retail level required human intervention to support the automated system | Excessive shipping and receipt posting errors and delays caused inventory accuracy problems, negatively impacting the effectiveness of contract and redistribution decisions. |
| CIFs, DLA depots, and 3PLs manually correlated NSNs with receiving documents, resulting in large numbers of receipt posting errors | |
| CIFs, 3PLs, and RTCs created delays and sometimes forgot to post receipts and shipments | |
| CIFs and 3PLs posted receipts and shipments as 80-column card images | |
| CIF and 3PL inventory records were not available to DSCP C&T | |

2.5 R&D Vision for CDUM

The CDUM rationale and purpose was to:

- Provide reliable / timely asset visibility and accountability;
- Track movements between physical locations;
- Substantially minimize human intervention and system errors (i.e., IDOCS);
- Provide near real-time accurate data;
- Establish quality check points throughout the supply chain;
- Provide high payback on return on investments;

2.6 CDUM Research Approach & Structure.

A flexible research approach and structure was needed for the non-recruit CIE supply chain. Effective management of non-recruit clothing is complicated by challenging aspects in design, material supply, manufacturing, storage, and operational performance. In addition, these clothing items have specific requirements for asset visibility, accountability, disposal and shelf-life management. There are challenges that spread across recognized functional processes, activities, and actions throughout these items' life-cycle. CDUM pilots are using selected ARN sites at manufacturers, 3PL depots, and the Air Force RTC at Lackland to emulate non-recruit clothing processes to test the effectiveness of the CDUM systems. One CIF site (i.e., Ft. Carson) is also being used as a pilot site. Each of the CDUM pilots and the associated projects are described in detail in the following sections of this document.

2.7 Condition after CDUM

The CDUM systems support more effective processes for manufacturing, wholesale, and retail operations. The foundation for all of these processes is a single source of data created from a dozen master sources of data that is used to pre-populate virtually everything that is done by the CDUM systems. Pre-population ensures that exceptionally high quality data is created and passed to the inter-related systems, improving the overall condition of the supply chain as follows:

| To-BE Conditions | Result |
|--|--|
| RFID tracking, accounting, and issuing of recruit and non-recruit CIE at the AFCIIF, LAFB and at the CIF, Ft. Carson has resulted in tight asset control and visibility from manufacturer to the Warfighter, and minimized human intervention. | CDUM has created a model system of excellence with: <ul style="list-style-type: none"> • Accurate RFID tracking and accounting of assets. • Data consistency between manufacturing, wholesale, and retail. • Data consistency between EBS and WAWF. • Single source of wholesale, retail and manufacturing data; • Pre-population of data-using processes to eliminate shipping and receipt posting errors, and to maximize inventory accuracy. • Accuracy and consistency equals total supply chain efficiency and reduced level of effort to resolve problems. |
| CIFs, DLA depots, and 3PLs all receive accurate, correlated data from the same source, and all systems are in agreement. | |
| CIFs, 3PLs, and RTCs receipts and shipments are automatically posted by RFID and source data automation, precluding errors and delays of the past. | |
| CIFs, 3PLs, and RTCs post receipts and shipments based on data consistent with EBS. | |
| CIFs, 3PLs, and RTCs automatically receive carrier tracking data as part of the manifest from ASAP. | |
| CIF, RTC, and 3PL inventory records are available to DSCP C&T. | |
| EBS is more effective because CDUM manufacturing, wholesale, and retail systems provide EBS with an unparalleled level of accurate data for all inventory transactions. Accurate data means that EBS can make effective decisions and that EBS resolution specialists do not need to waste time resolving data quality problems. | |
| WAWF is more effective because CDUM data is always 100% consistent with EBS contract data. | |
| DFAS is more effective because CDUM data is always 100% consistent with EBS contract and WAWF receiving and invoice data. Consistent data means that CDUM payment processing can utilize DFAS's fully automated processes because there are no requirements for manual exception handling. | |

2.8 Tasks Summary

| Pilot 1 – Project Tasks at AFCIIF Lackland Air Force Base (LAFB), Travis 3PL, Warmkraft & Propper | |
|--|---|
| RFID – AdvanTech, Inc. (ATI) | Task Description and Objective: Investigate and implement advanced technologies to track recruit clothing assets, simulating hard to procure items, from manufacturers through wholesale to the Warfighter to maintain asset visibility, improved data management, and to improve end-to-end management throughout the CIE life cycle. |
| 3D Whole Body Scanner – ATI & Human Solutions | Task Description and Objective: Investigate and implement advanced technologies to obtain individual body measurements of 155,000 male and female recruits, and translating those body measurements into size predictions for Phase I and dress uniforms. |
| Foot Scanner - LMI | Task Description and Objective: Assess the accuracy of the I-Step measurement device by determining its prediction rates as compared to actual boot, running shoe, and dress shoe issued sizes. Compare prediction rates between the I-Step and Brannock® measurement devices. |
| Travis 3PL – Modulant | Task Description and Objective: Utilize AIT (RFID and bar codes) to identify all incoming and outgoing shipments to pre-populate all receiving and shipment transactions for EBS and Travis' 3PLs warehouse management system. Provide 3PL shipment and receipt visibility to DSCP C&T and the 3PL's customers. |
| Manufacturing – RFID Case and Pallet – Modulant | Task Description and Objective: Update VIM-ASAP to comply with MIL-STD-129P and the corresponding WAWF interface to capture case and pallet level RFID tagging for all C&T contracts that require RFID tagging. Provide the RFID tagging data to all downstream functions to improve their receiving and tracking processes. |
| VIM-ASAP - Modulant | Task Description and Objective: Improve C&T manufacturer's shipment accuracy and visibility and the reliability of the payment process by utilizing EBS contract data to pre-populate virtually all data required for the manufacturer's preparation of each DD250 and Military Shipment Label (MSL). |
| Warmkraft Item Level RFID – Modulant & ATI | Task Description and Objective: Investigate and integrate RFID item tagging into the manufacturing process, linking items to the RFID case tag. Improve accuracy of item counts within each case, and track items by NSN or finished good lot number through the supply chain. |
| Propper Item Level RFID – ATI | Task Description and Objective: Investigate and integrate RFID item tagging into the manufacturing process to identify a cost effective alternative to the aggregator at Warmkraft. . |

| Pilot 2 - CIF Initiatives – Army Ft. Carson, CO | |
|--|--|
| RFID – ATI | Task Description and Objective: Investigate and implement advanced technologies to track CIE assets from turn-in through preparation for re-issue, down to the Warfighter, to maintain asset visibility, improve data management, and to improve end-to-end management throughout the CIE life cycle. |
| 3D Whole Body Scanner – ATI/HS | Task Description and Objective: Investigate and implement advanced technologies to obtain individual body measurements of the Warfighters, and translating those body measurements into CIE size predictions for 20 LINs and 169 NSNs. |
| Legacy System – ATI | Task Description and Objective: Obtain authorization for CDUM access to Army ISM property book data, and pull the data into the CDUM database for synchronization of asset management for replenishment and for inventory location and quantity management. |

| Shade Study Task | |
|-------------------------------|--|
| Shade Study Task – LMI | Task Description and Objective: Assess the use of technology in support of government apparel fabric shade evaluations. Investigate whether there is correlation between spectrophotometer measurements of shade absolute values and shade measurement differences. Also, investigate the correlation between trained human observers and spectrophotometers in determining pass/fail for shade evaluation. |

3.0 Pilot 1 – AFCIIF, Lackland Air Force Base (LAFB) and Travis 3PL

3.1 AFCIIF, Lackland Air Force Base (LAFB) – RFID – AdvanTech, Inc.

Background: Clothing and individual equipment (CIE) receipts and stock movements at the retail level required human intervention - data entry and issue scan forms - to support the automated system that had been installed as part of ARN. In 2007 CDUM began investigating the use of advanced technologies to overcome inefficiencies in the retail segment of the supply chain. It began to employ automatic identification technology (AIT) in the form of RFID tags on items, cases, and pallets to track assets, and to expedite movement of CIE through the supply chain from the manufacturers to the Warfighter.

Task Description and Objective: As illustrated in Figure 3.1, recruit clothing assets, specifically the Air Force Battle Uniform (ABU), were employed to simulate hard to procure and hard to manage non-recruit CIE (chemical suits as an example) when it was not feasible to do so with non-recruit CIE. In this task the objective was to investigate and implement advanced technologies to track ABUs from manufacturers through wholesale and down to the Warfighter to maintain asset visibility, improved data management, and to improve end-to-end management throughout the CIE life cycle.

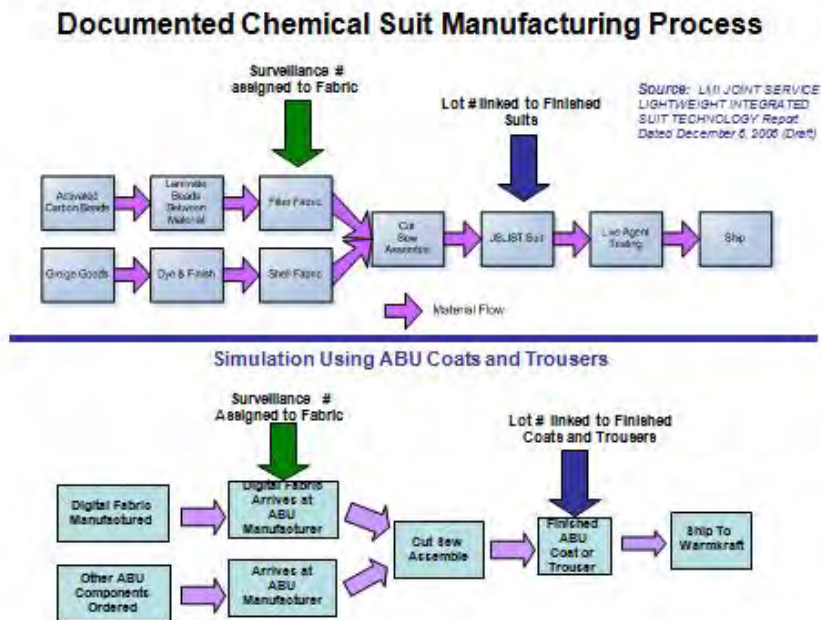


Figure 3.1.1: Simulation Using ABUs

At the start of this project, RFID tags were not applied anywhere along the supply chain. Incremental steps were employed to prove the concept at logical junctures along the supply chain in preparation for the advent of RFID tagging at the manufacturing segment. The incremental steps employed by CDUM to attain end-to-end management and accountability along the retail supply chain included:

- **Pallet Level.** RFID tags were applied to pallets at the 3PL when they were destined for the AFCIIF, LAFB. The pallets were weighed, and the weight and contents were manifested in VIM-ASAP. Upon receipt at the AFCIIF the pallets were weighed, RFID tags were read and matched to the manifest. If within tolerance the contents as shown in the manifest were received into inventory.

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- **Portal Installation.** RFID portals were installed at the AFCIIF: one at the main warehouse receiving door, and one at the main issue in preparation for tracking of assets into and out of the main warehouse, and into main issue. Asset location and accountability tracking was initiated, and asset status was recorded in the CDUM central server.
- **Case Tagging.** RFID tags were applied to cases, initially by the AFCIIF and CDUM personnel until all cases in the AFCIIF warehouse were tagged. Thereafter CDUM and the 3PL began tagging cases destined for the AFCIIF. Cases could now be tracked through the main receiving portal, matched to shipping information in VIM-ASAP, and received into AFCIIF inventory.
- **Item Tagging.** As cases passed through the main issue portal, RFID tags were printed for the items in the case, and the AFCIIF initiated application of RFID tags to all items that would be picked and put into the Warfighter's "issue bag" as shown in Figure 3.2. At check out the "issue bag" was placed on a countertop or passed through a portal. The RFID tags were read and the items were recorded into the issue record.
- **End-to-End Retail RFID Infrastructure.** The process and infrastructure were now in place to demonstrate end-to-end tracking of pallets, cases, and items from receipt at the warehouse to issue to the Warfighter. This demonstrates the tracking of manufacturer tagged items and the merits of RFID physical inventory.



Figure 3.1.2: RFID Issue Process

Benefits: CIE receipts, stock movements, and issues at the retail level have been automated, thereby minimizing errors, maximizing inventory accuracy, minimizing stock-outs, expediting physical inventory, and accurately updating EBS.

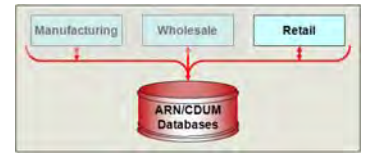
Statistics:

| Metric | Result |
|-----------------------------------|--|
| Portal Read Rate – Pallet Labels | 100 % |
| Portal Read Rate – Case Labels | 98 % |
| Read Rate – Item Tags at Checkout | 99 % |
| Flight Issue Process | Reduced from 2 ½ hours per flight to 45 minutes |
| Physical Inventory Counting | Reduced from 2 days to 6 hours |
| Physical Inventory Variance | Reduced from 2 ½ - 4 % to 0.15 – 0.20 % |
| Main Receiving Process | Reduced from 4 hours to 20 minutes |
| Recruit Issue Checkout Process | Reduced from 1.5 minutes with paper to 6 seconds with RFID |

Current Status and Future Plans: CIE retail assets are currently being tracked by RFID from receipt to issue. RFID is used for physical inventory. Manufacturer tagged items are entering the system and are being tracked into the AFCIIF. Future plans include tracking of items from manufacturer to the Warfighter, enhancement of check-out process using thin advanced technology, and enhancement of warehouse operations through real-time location management.

3.2 AFCIIF, Lackland AFB – 3D Whole Body Scanner – AdvanTech, Inc. & Human Solutions

Background: Issue procedures varied within the AFCIIF, ranging from self reporting of sizes and item needs and recruits measuring other recruits to fitters measuring, issuing, and/or tailoring finished garments. This yielded great variance in fit quality, feedback loops arising from out-of-stock situations continually skewing inventory control, unnecessary alterations, and a long total issue time – as measured from the time in-the-door to completion of the issue process. The 3D Whole Body Scanning technology and process was investigated as an alternative to the traditional procedure of item size selection.



Task Description and Objective: The 3D whole body scanning technology was integrated into Virtual Item Manager-Integrated Retail Module (VIM-IRM) system that CDUM implemented for inventory management at the AFCIIF. Body measurements from the scanning process are sent to VIM-IRM where they are extracted and an algorithm is applied to predict the appropriate size for each item for each Warfighter. This algorithm is continually improved to reflect the final size selections. A scannable check-box form is printed with the soldier's particular menu items listed in order of most-likely sizes. The initial size selection is determined accurately and without delay resulting in an issue process that is faster, more accurate, and considerably more stable. The objectives were to investigate and implement advanced technologies to obtain individual body measurements of the Warfighters by developing software to translate body measurements into size predictions for recruit, both male and female, Phase I and Dress Uniforms.

Benefits: Benefits are summarized in Figure 3.2.1:

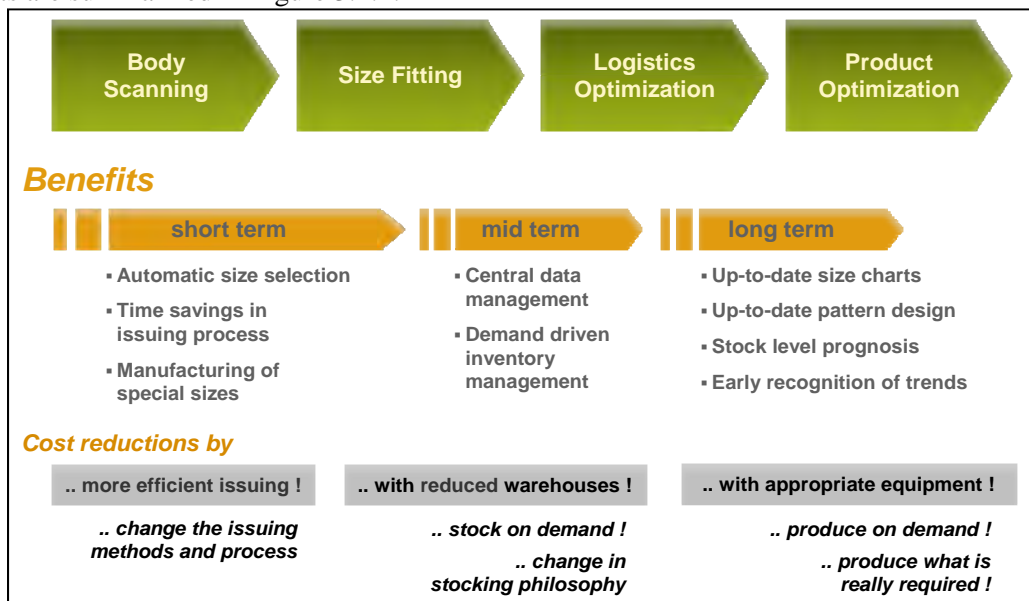


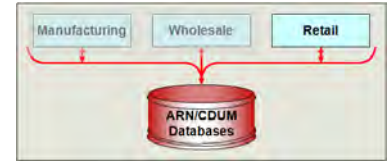
Figure 3.2.1: Whole Body Scanning Benefits

| Statistics: Metric | Result |
|-----------------------------|--|
| ABU Jacket Size Prediction | Correct size 92 % of the time |
| ABU Trouser Size Prediction | Correct size 86 % of the time |
| Dress Uniform – All pieces | Plus or Minus 2 Sizes = Correct size 85% of the time |

Current Status and Future Plans: All recruits enter the 3D whole body scanner on day one in the night room at LAFB. Body measurements are developed and translated to sizes for individual uniform items, and are used to select sized items during the fitting process. The AFCIIF has taken ownership and will continue to use the 3D whole body scanner as an integral part of the clothing initial issue process to expedite the issue of both training and dress uniform items.

3.3 AFCHIF, Lackland AFB - Foot Scanner – LMI

Background: Anecdotal evidence indicates that approximately 40% of new Air Force trainees are exchanging their boots for a different size between initial boot issue and second boot issue. Each exchanged boot is either salvaged or sold at a discount. Issue of improper boot size equates to potentially up to 16,000 pairs of boots salvaged, in addition to many foot injuries. A study was devised and conducted to analyze the use of an automated foot measurement device (I-Step) and a Brannock foot measurement device. The analysis determined the most accurate of the two measurement devices to help mitigate boot and shoe exchanges due to improper fit during basic training.



Task Description and Objective: The objectives of this study were to:

- Assess the accuracy of the I-Step measurement device by determining its prediction rates as compared to the eventual boot, running shoe, and dress shoe issued sizes.
 - Compare prediction rates between the I-Step and Brannock measurement devices.
- **Data Collection.** Data was collected for over 400 recruits over an eight week period. The eight weeks allowed for the capture of information on all exchanges that occurred during basic training – to include any exchanges between initial issue and graduation. For each recruit, the following data was collected:
- I-Step size prediction
 - Brannock size prediction
 - Initial boot size issued
 - Second boot size issued
 - Running shoe size issued – since running shoes are provided by AAFES, no running shoe exchanges were documented. Initial running shoe issue was used as best fit.
- **On Hand Stock Considerations.** Two sets of data were analyzed; one where records include boot and dress shoe quantity on-hand of zero or less than zero (stock-out condition) and a second set where records with quantity on-hand is greater than zero (available stock condition). Since the data set with the available stock condition indicated a greater accuracy for both devices, only the data with an available quantity on-hand was used.
- **Footwear Manufacturer.** There were boots supplied from four manufacturers, running shoes supplied from three manufacturers, and dress shoes supplied by two manufacturers. Even though boots and shoes are made to national stock number requirements, they can still differ in how they fit based on the manufacturer of the item. The analysis included an assessment on how well the devices predicted accurate footwear size by manufacturer.

Findings: Utilizing the automated I-Step devices resulted in a higher percentage of correctly predicting boot, dress shoe and running shoe sizes in comparison to the Brannock foot measurement device.

Other findings included:

- The out of stock condition for footwear sizes negatively impacted the prediction of sizes for both the I-Step and Brannock devices.
- Both devices had a higher level of accuracy in predicting male footwear sizes in comparison to female footwear sizes.
- The prediction accuracy for both devices was consistent for three of the four boot manufacturers. Size predictions for female footwear from the fourth manufacturer were extremely low for both devices.

All statistics to support the benefits and findings presented above are provided in the posted results.

Current Status and Future Plans: At the conclusion of the study, the results as shown in Figure 3.3.1 were published. No further activity related to foot scanner evaluation is planned.

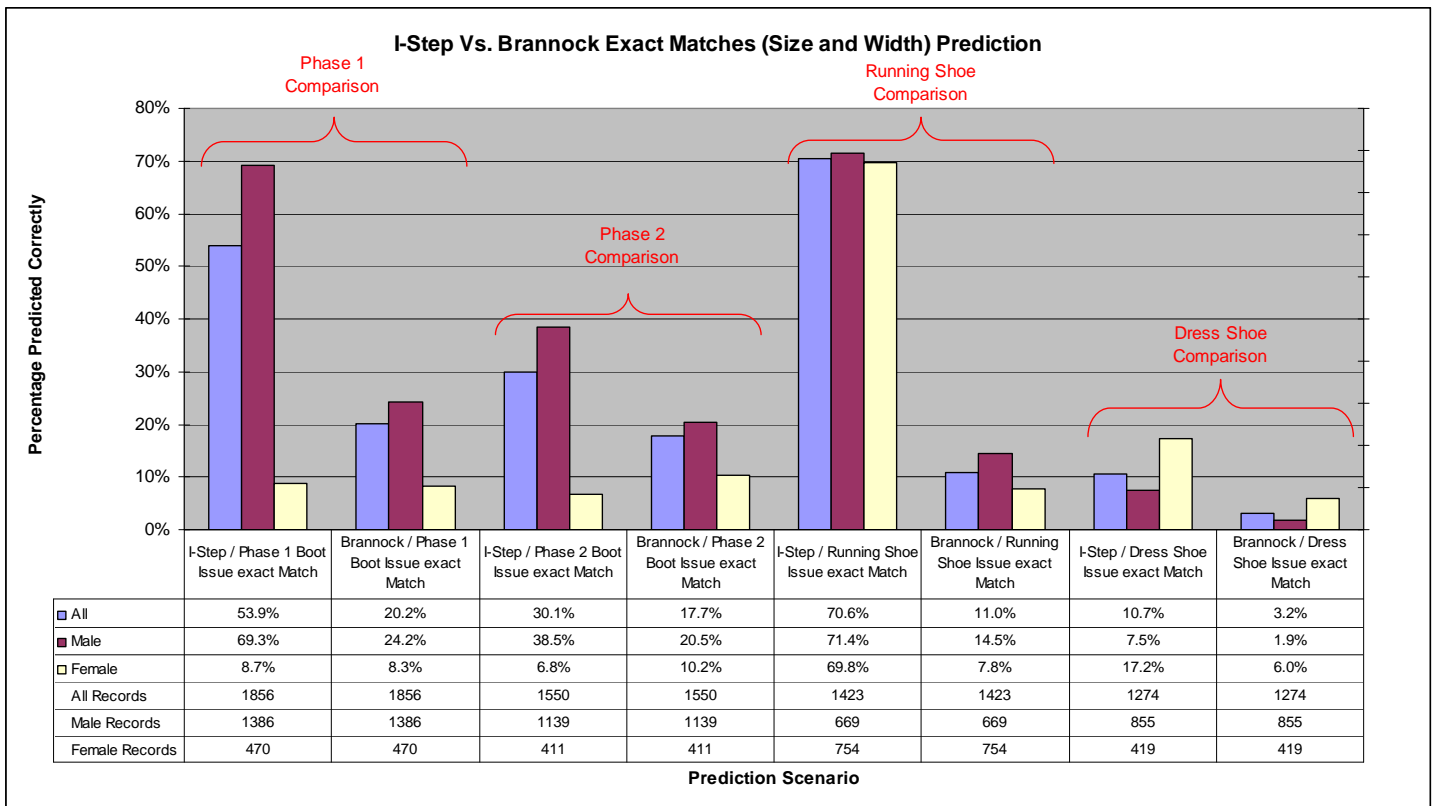
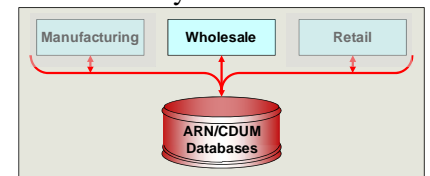


Figure 3.3.1: Prediction Scenario

3.4 Wholesale Pilot for Travis' 3PL – Modulant

Background: The foundation for effective DSCP C&T decisions includes the visibility, quality, completeness, and timeliness of the total supply chain data. The combination of ARN and CDUM developed wholesale systems are responsible for providing DSCP C&T with an unparalleled level of data quality, completeness, and timeliness for receiving visibility. Timely and accurate identification of depot receipts is critical to making effective decisions and for getting shipments of short supply items to requestors in a timely manner. The inconsistency of the content and format of the documents that accompany the non-RFID shipments caused CDUM to develop multiple methods for identifying each shipment. The standard and most common method is the bar code scan of the TCN on the MSL which normally are attached to shipments from manufacturers, but rarely found on retail returns.



Task Description and Objective: The objective of this task was to completely eliminate back-office manual data entry and the resultant delays and errors.

Both bar code and RFID portal scanning utilize ARN and CDUM data to pre-populate all receiving data so that receiving dock personnel only need to confirm receipt quantities to generate 100% consistent updates for their local warehouse management system and EBS. CDUM's wholesale capabilities are built upon the foundation of the ARN developed shipment data (VIM-ASAP DD250s and EBS MROs and RDOs) and the CDUM developed RFID data (pallet, case, and sometimes item level RFID). The CDUM developed RFID data is utilized for 35% of the receipts by an RFID portal on the receiving dock (see Figure 3.4.1) to identify the incoming shipment and confirm the contents of each pallet as it passes through the RFID portal. Non-RFID shipments are processed for 65% of the receipts with the aid of a bar code scanner to identify the contents of each shipment.



Figure 3.4.1: 3PL Receiving Utilizing Bar Code and RFID Portal Scanning

The two primary receiving processes (see Figure 3.4.1) include:

1. A bar code scan of the MSL that is attached to each shipment is utilized with the CDUM in-transit data to identify the authorization (e.g., contract/shipment number) and the contents of each shipment (i.e., NSNs and quantities). Receiving dock personnel only need to do manual data entry if there is a discrepancy between the shipped and received quantities. Once counts are confirmed, CDUM transmits all required receipt data to update the local warehouse management system and EBS with identical data, eliminating discrepancies between the two systems.
2. A portal scan of the RFID tags on the pallet(s) passing through the RFID portal is utilized with the CDUM in-transit manufacturing data from VIM-ASAP to identify the authorization (i.e., contract/shipment number) and the contents of each pallet (i.e., RFID case tags, NSNs, and quantities). A large screen display is near the RFID portal to display the cases on each pallet so the fork lift operator knows the contents of each pallet. Each case that is seen by the RFID portal is displayed with a green background. Each case that should be on the pallet, but that was not seen by the RFID portal is displayed with a red background. The forklift operator utilizes a wireless hand-held pointer to click on the red cases if the case is actually on the pallet, but not detected by the RFID portal. These cases are then recognized as received. If not clicked, they are treated as not received. Once counts are confirmed, CDUM transmits all required receipt data to update the local warehouse management system and EBS with identical data, eliminating discrepancies between the two systems.

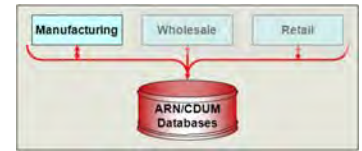
Benefits The use of RFID portals and bar code scanning has improved the timing and accuracy of 3PL receiving and eliminated the back-office manual data entry process. EBS and DSCP C&T personnel are now being informed of receipts in a more timely and accurate way with MROs/RDOs being released to the 3PL so quickly that they are getting the orders before they have a chance to put the shipments away. The CDUM developed process and system, worked collaboratively with Travis is helping to eliminate inaccurate EBS inventory levels.

Statistics: The first use of the bar code reading hand-held scanner occurred on April 3, 2008. As of October 25, 2009, the hand-held has been used to receive 56,353 CLINs from DD250s and 3,930 MROs or RDOs. The RFID portal was used to receive its first RFID shipment on August 12, 2009. A small number of additional receipts occurred until September 30, 2009 when the daily use of the RFID portal began. Since that time, the RFID portal has been used to process 311 CLINs from DD250s through October 25, 2009.

Current Status and Future Plans: Travis' 3PL has taken ownership of the CDUM initiative, are impressed with the added accuracy, will continue to integrate it into their work processes, and train their personnel to use it effectively.

3.5 Enhance CDUM Database Capability – Modulant

Background: The foundation for effective DSCP C&T decisions includes the visibility, quality, completeness, and timeliness of the total supply chain data. The combination of ARN and CDUM developed manufacturing systems is responsible for providing DSCP C&T with an unparalleled level of data quality, completeness, and timeliness for manufacturing contract and shipment visibility.



Task Description & Objective: The CDUM objective was to use the ARN foundation to 1) replace the interface to a DFAS system called WINS with an interface to WAWF which brought the QAR into the closed loop process; 2) support the capture of pallet and case level RFID for shipments per MIL-STD-129P; 3) provide 3PL and other sites with shipment visibility along with the data required to pre-populate receiving transactions; and 4) provide for expanded visibility for DSCP C&T personnel with such things as automatic email notifications whenever a shipment is made.

CDUM's manufacturing capabilities are built upon the foundation of the ARN developed VIM-ASAP system. The ARN developed system provided C&T manufacturers with direct access to contracts and related data so that shipments and invoices could be pre-populated with all required data, eliminating chronic problems with data entry errors while ensuring a one-hundred percent match between the contract, invoice, and acceptance report. This three-way match has virtually eliminated payment delays

Benefits: VIM-ASAP is a web site used by DSCP C&T manufacturers to prepare all shipment documents and transactions that eliminate mismatches between contracts, invoices, and acceptance data. The success of the system can be seen in the virtual elimination of late payments and the resultant reduction in DLA's interest payments. VIM-ASAP's automatic email shipping alerts developed by CDUM have also been of value to DSCP C&T personnel as noted by Peter Monteleone in an email dated 6/11/2009 "...receiving the shipping alerts via email is vital to our mission...".

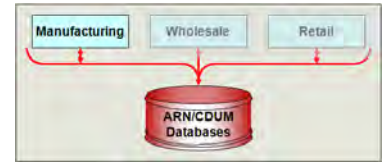
Statistics: The following statistics were collected from VIM-ASAP for all of calendar year 2008.

| Process | Counts |
|---------------------------------------|-----------------|
| Active VIM-ASAP Shipment Sites | 380 |
| DD250s Shipped | 47,690 |
| CLINs Shipped | 167,409 |
| DD250 Invoice Value | \$1,952,886,496 |
| RFID Shipment Sites | 123 |
| RFID Case Tags | 1,284,711 |
| MIL Transactions (D4, D6, AR, and A6) | 11,842 |

Current Status & Future Plans: VIM-ASAP has become an integral part of the manufacturers' shipping process, and is expanded to other manufacturers as they are identified or become DSCP C&T contractors.

3.6 Manufacturing Pilot for Item Level RFID at Warmkraft - Modulant/ATI

Background: The foundation for effective DSCP C&T decisions includes the visibility, quality, completeness, and timeliness of the total supply chain data. The combination of ARN and CDUM developed manufacturing system is responsible for providing DSCP C&T with an unparalleled level of data quality, completeness, and timeliness for manufacturing contract and shipment visibility. Item level RFID extends the data quality to the contents of each case and the total shipment.



Task Description & Objective: The objective of this task was to prove 1) the feasibility of RFID Item level tagging and association of the items with their designated case, and 2) the ability to track items and cases through the supply chain to the Warfighter.

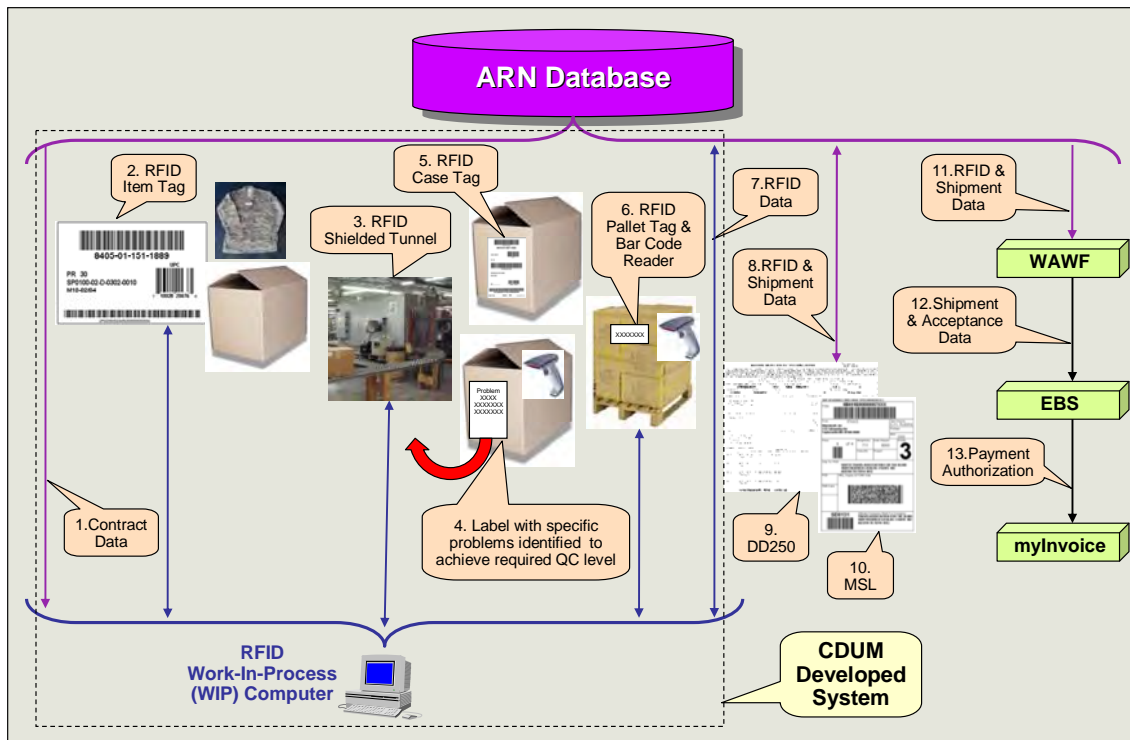


Figure 3.6: Item Level RFID Data Capture via VIM-ASAP and WAWF

The specific process steps (see Figure 3.6) include:

1. Contract Data is provided by the CDUM database using the standard ARN data exchange format to the RFID work-in-process (WIP) computer for use in generating all required RFID tags
2. The RFID WIP computer generates the required number of item level RFID tags using the CDUM contract data and for the quantity and NSN specified by the user. The item level tags are attached to each garment and the garments loaded into a case.
3. Each case is moved through the shielded tunnel for a complete quality control confirmation of the contents of each case. The checks include the correct quantity of NSNs in each case; only a single NSN in each case, the NSN is valid for the pertinent contract, etc.
4. All problem cases get a stick-on label that identifies all problems that must be resolved before the case can be shipped.
5. Cases that pass the quality control check receive an RFID case tag that is attached to each case.

CDUM-1 WRAP-UP REPORT

6. Each case is loaded onto a pallet by using a hand bar code scanner to correlate the case with the pallet. Once a pallet is loaded, an RFID pallet tag is printed and attached to the pallet.
7. The complete set of item, case, and pallet level RFID data is passed to ARN using the standard WAWF data exchange format. A complete data validation process is conducted to ensure that the data is correct (no duplicate RFID tags, NSN quantities do not exceed order quantities, etc.). Invalid data is rejected while valid data is processed by the normal VIM-ASAP process.
8. ARN provides the VIM-ASAP web site for the vendor to complete the required documentation.
9. The first required document is the DD250 that is built from the contract, RFID data, and user inputs
10. The second document is the Military Shipment Label (MSL) that uniquely identifies each shipment.
11. The pertinent RFID and shipment data is transmitted to WAWF using the WAWF specified data exchange format
12. After approval by the QAR, WAWF transmits the DD250 invoice along with the QAR acceptance data to EBS to record the shipment
13. EBS uses the combination of invoice and acceptance data to generate payment authorization to DFAS. Before this is done, EBS performs a data validation to ensure that the invoice and acceptance data matches the contract data.

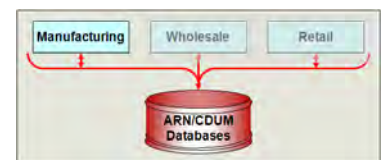
Benefits The automatic capture of item, case, and pallet level RFID has become a valuable tool at Warmkraft to significantly improve the accuracy of the physical contents of each shipment and the data associated with each shipment. Ron Lack, Warmkraft's General Manager has commented on several occasions that his packaging accuracy is now outstanding and gone are the days when he needed to tear apart an entire shipment to find the cases that were incorrectly packed.

Statistics: During the months of August and September 2009, Warmkraft shipped 132,240 item level RFID tags in 4,408 cases. The RFID scanning tunnel found that 15 of the items were not in the cases while 167 items that were in the cases were missing item level tags. The tunnel also found that there were 17 extra items in cases while there were 79 extra tags, but not extra items in the cases.

Current Status & Future Plans: Item Level RFID tagging is operational. It is an integral part of the manufacturer's shipping process, has proven to be an effective method of tracking shipments, and is being expanded to other manufacturers under a separate CDUM initiative.

3.7 Proper Manufacturing - RFID - AdvanTech, Inc.

Background: Proper International, Puerto Rico, manufacturer and finisher of Air Force Battle Dress Uniforms (ABUs), was designated as a pilot for the CDUM item level RFID pilot and roll-out Plan for RFID-tagging of Air Force items. The intent was to find and demonstrate an alternative hardware / software configuration an approach to that taken at Warmkraft, another manufacturer of ABUs (see Task 3.6).



Task Description and Objective: Item level RFID tags are prepared and attached to each ABU item towards the end of the manufacturing process. The item level tags are scanned as the case is prepared and a case level RFID tag is prepared and attached to the case. The case level tags are scanned as the pallet is prepared and a pallet level RFID tag is prepared and attached to the pallet. This creates a well defined association between all three levels of RFID tags. The association data for each contract is then passed from the RFID vendors to CDUM for review and disposition of the RFID data.

➤ Project Objectives:

- ◆ The primary objective was to identify an alternative configuration and to improve the accuracy of item counts within each case, and track items by NSN or finished good lot number through the supply chain to the individual Warfighter.

CDUM-1 WRAP-UP REPORT

- ◆ To develop and assess RFID item tagging technologies for ABUs at Propper International, and to improve the manufacturing process.
- ◆ To examine and/or identify lower cost RFID reader solutions that are transportable to other DSCP C&T manufacturers by evaluating hand held terminal (HHT) readers and a lower cost fixed reader.
- ◆ To achieve similar tag write and read results to the tunnel design solution currently at Warmkraft.
- ◆ To demonstrate select item information visibility throughout the entire supply chain for improved inventory accuracy.
- ◆ To demonstrate RFID item and case tagging and linkages at Propper are readable and can support other supply chain activities – specifically the issue of ABUs to Warfighters at the AFCIIF, LAFB.

Benefits: Item level RFID tagging at the manufacturing level permits DSCP C&T to demonstrate item level tracking down to the AFCIIF, LAFB, enhancing asset accountability and visibility, and to demonstrate the tracking and locating of critical, hard to procure, and manage items, (e.g. JSLIST, ESAPI) for simplified and expedited the shipping process.

Statistics:

| Metric | Result |
|---|---|
| Fixed reader Station | Read and validate a full case in 4 – 6 seconds |
| Hand held read | Read and validate a full case in 20 – 30 seconds |
| Alternative to aggregator – Start up hardware Costs | Fixed read alternative is 1/20 cost of aggregator tunnel |
| Alternative to aggregator – Ongoing support / maintenance | Fixed read alternative monthly cost is 1/3 the aggregator |

Current Status and Future Plans:

- The Propper RFID process is in daily operation with two fixed reader pack stations to link items to case.
- Propper is using fixed readers for linking items to the case label.
- Propper is using handhelds for the shipping process, for linking case to pallet.
- A cost effective alternative to the aggregator was identified as shown in Figure 3.7. Propper will take ownership of the configuration, and will continue to RFID tag items, cases, and pallets destined for Air Force issue.

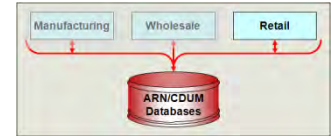


Figure 3.7: Fixed Reader Pack Station

4.0 Pilot 2 – Army Central Issue Facility Initiatives – Ft. Carson, CO

4.1 Army CIF Ft. Carson – RFID – AdvanTech, Inc.

Background: CIE issuing at the Central Issue Facility (CIF), Ft. Carson, required human intervention - data entry and issue scan forms - to support the automated system that had been installed as part of ARN. In 2006 CDUM began investigating the use of advanced technologies to overcome inefficiencies in the issuing of CIE to non-recruits. It began to employ automatic identification technology in the form of RFID tags on new and used items, and reading of the RFID tags on the items issued to the Warfighter.



Task Description and Objective: CDUM investigated and implemented a process of applying RFID tags to all new and used CIE items before they were placed on the issue line. As new items moved to the issue line from bulk stock, CDUM personnel applied RFID tags. As used assets were turned in and prepared for re-issue to the Warfighters, CDUM set up an Internet-based smart data collection network to eliminate the need for local client-server functions. Listener software was installed on the network. As RFID receipt, shipment or stock movement transactions occurred they were directed into the appropriate functional management area of CDUM-CIE, be that receiving, shipments or stock movements. The objectives of this CDUM effort were to: 1) determine the most effective approach to applying RFID labels and hang tags to CIE, and the recording of asset status within the retail supply chain using listener software; 2) maintain asset visibility, distinguish new and used items, and establish an infrastructure with the feasibility to simulate the tracking and accounting for critical items; and 3) expedite the issuing process by eliminating manual and paper processing, and instituting rapid countertop reading of RFID tagged items when the Warfighter passes through the check-out station. (Figure 4.1)

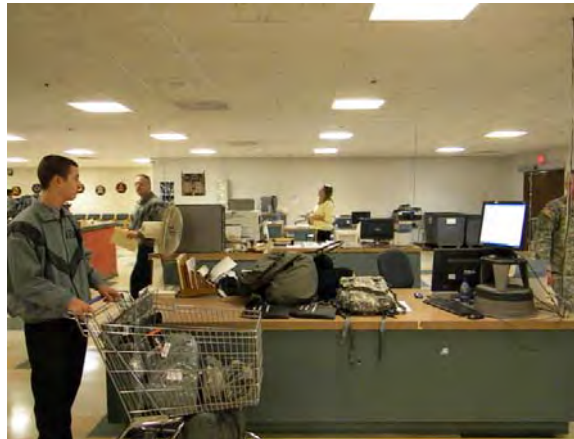


Figure 4.1 – RFID Issue Process

Benefits: The process provided the means to achieve new and used asset visibility at the lowest possible level (unit of issue/individual user) and to simulate the recall and/or accounting for failed or suspect items. It expedited the issuing of CIE, and instituted rapid recording of issues at the check-out station. Smart data collection reduced hardware and software infrastructure at the local level, by using RFID technology to institute an automatic process for supply chain control and capture of asset movement and status.

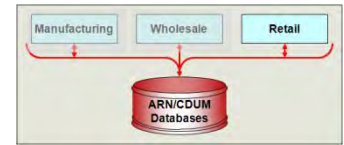
Statistics:

| Metric | Result |
|----------------------------------|--------------------------------------|
| Number of Scan Checkout Stations | Paper = 3 Stations; RFID = 1 Station |

Current Status and Future Plans: RFID tags are applied to both new and used CIE. RFID tags are applied to 20 LINs & 169 NSNs to simulate the process as it would be if RFID tags were applied by the manufacturers, and to simulate tracking and accountability of critical items of CIE. The infrastructure is in place for further demonstration of tracking and recall of critical items.

4.2 Army CIF Ft. Carson – 3D Whole Body Scanner – AdvanTech, Inc.

Background: Issue procedures varied within the CIF, ranging from soldiers' self reporting of sizes of items needed, to soldiers being issued sizes that were on hand and waiting until requested sizes were available and then doing exchanges. The result was inaccurate usage data, which led to inaccurate sizes being reordered for replenishment. There was no accurate due-member data for soldiers that requiring out of stock sizes at the time of issue. The 3D whole body scanning technology and process, as shown in Figure 4.2, was investigated as an alternative to the traditional item size selection.



3-D Body Scanner Components



Figure 4.2: 3D Whole Body Scanning

Task Description and Objective: The 3D whole body scanning technology was integrated into VIM-IRM for inventory management of CIE at the CIF. Body measurements from the scanning process are sent to VIM-IRM where they are extracted and an algorithm is applied to predict the appropriate size for many of the sized CIF items to be issued to the soldier. The predicted size for a wide range of CIE are determined, and are printed on issue forms prior to the Warfighter going to each issue station. The correct size to be issued is determined accurately and without delay. The objectives were to 1) investigate and implement advanced technologies to obtain individual body measurements of the soldiers; 2) investigate and implement software to translate body measurements into size predictions for soldiers, both male and female, while continuously evaluating the accuracy to determine where modifications to the size-selection algorithm were needed; 3) investigate, develop, and validate dynamic local tariffs for use by CIF managers when requesting replenishment equipment from DLA.

Benefits: Benefits include: 1) greater asset visibility, reduced issue times, fewer exchanges, stock optimization, more consistent fitting, improved initial fill rates, and accurate due member data used for replenishment orders from the CIF; 2) both males and females are scanned by scan operators, sized, issued items without a fitting expert, alleviating the need for a dedicated fit expert for measuring; and 3) acquiring body measurements gives a sophisticated understanding of the distribution of soldiers' physical characteristics, useful in future systems and apparel design.

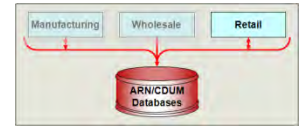
Statistics:

| Metric | Result |
|---|--------|
| Fitting Rates based on size issued, compared to predicted sizes | 42 % |
| Fitting Rates factoring out personal preference and "Out of Stock" situations | 58 % |

Current Status and Future Plans: All soldiers receiving their initial CIF issues, enter the 3D whole body scanner in the CIF prior to the issue process. Body measurements are developed and translated to sizes for individual equipment items. The Ft. Carson CIF will continue to use the 3D whole body scanner as an integral part of the CIF equipment initial issue process to expedite the issue of supplemental uniform items and individual combat equipment.

4.3 CIF Ft. Carson – Legacy System – AdvanTech, Inc.

Background: In 2004 VIM-IRM was implemented at the Ft. Carson CIF to capture issues of individual equipment to soldiers joining Ft. Carson units. Access was granted to the Army Installation Support Module (ISM), and an interface was created to import IRM issue data into ISM automatically.



Task Description and Objective: The objective was to obtain access to ISM for the purposes of automating the issue data import process from IRM, and to allow the export of all ISM property book data into CDUM for more efficient location management and inventory processes. The light blue boxes in Figure 4.3 highlight the data integration. The incremental steps employed by CDUM to achieve a seamless interface with ISM, and to streamline the capture of issue data and the location and inventory procedures were:

- **IRM Issue Data Interface.** The ISM IRM import interface was created to automatically import IRM issue data directly, via .XML format, into ISM at the conclusion of each business day.
- **ISM Property Book Export.** CDUM personnel were granted access to the query system used to access ISM property book data. They were able to create and execute automated queries to extract inventory data that included multiple condition codes and all location data for the particular CIF. This data was exported from ISM in Microsoft Excel format.
- **Importing ISM Property Book Data into CDUM.** Import routines were created to automatically import the property book data directly into the CDUM databases.
- **CDUM Inventory Module.** The ISM property book data is now resident and current in CDUM. CIF personnel utilize the CDUM web site in conjunction with hand-held terminals (HHT) to produce bar-coded location labels and conduct location surveys. CDUM provided an improved inventory process using either HHTs or count sheets to conduct both spot and wall-to-wall inventories.

Benefits: CIF personnel capture the initial issues to the soldiers via the optically scanned issue forms and import that data, saving half the key-entry time and eliminating key-entry errors. CIF personnel can easily view on the CDUM web site their total stock posture, including location data in a single application. CDUM provided the capability to conduct spot inventories and greatly improved and simplified the wall-to-wall inventory process starting in December 2007. The CIF Supervisor was impressed by the expedited process and intends to continue this time-saving process.

| Metric | Result |
|---------------------------------|---|
| Capture Individual's Issue Data | Reduced from 4 minutes to 1 minute with VIM-IRM |
| Physical Inventory | Reduced from 5 days to 3 days |

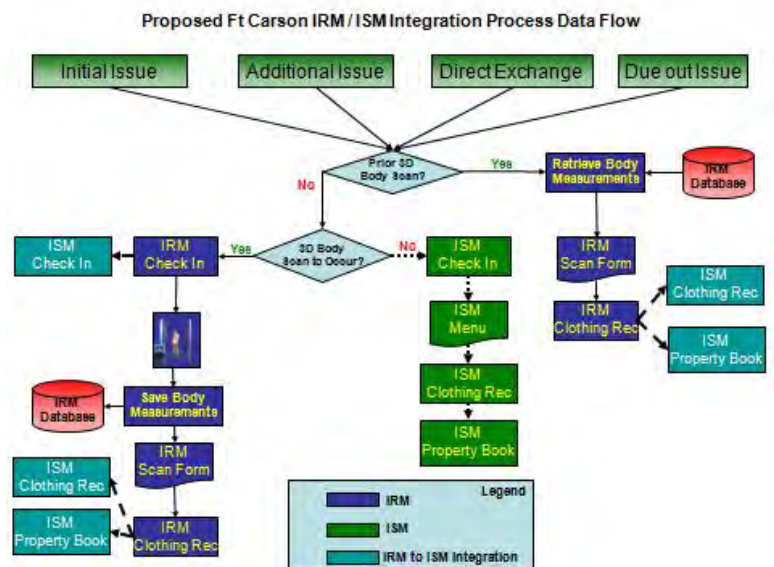


Figure 4.3: IRM / ISM Integration

Current Status and Future Plans: All initial issues to newly arriving soldiers are captured using IRM, and in December 2009 the CIF will conduct their third wall-to-wall inventory using the CDUM Inventory Module. Future development of IRM should include the capability to capture supplemental issues to soldiers along with exchanges.

5.0 Shade Study – LMI

Background: The current method for shade evaluation and acceptance of military fabric is conducted using visual assessment. Visual evaluation is commonly preferred over instrumentation evaluation because the human eye can detect more color variation than instrumentation. While visual evaluation is preferred, it tends to be more subjective when compared to the quantitative results that instrument measurements provide. It is common practice in industry to use instrumentation evaluation to support production. Both the military shade evaluation laboratories and fabric suppliers are interested in investigating the use of instrumental measurement to support visual evaluation when determining the acceptability of military fabrics. However, some believe spectrophotometer measurements taken at different evaluation sites would not match – or even correlate – well enough to be used in acceptability testing of shade. To address this, LMI in coordination with US Army Natick Soldier Research, Development, and Engineering Center, was asked to confirm or reject the assumption instrumental shade measurements do not correlate and therefore unreliable.

Task Description and Objective: The objective of this study was to determine if spectrophotometer readings are sufficiently equivalent and consistent among industry and government shade evaluation laboratories. The study examined 3 questions associated with instrumentation measurements at different shade evaluation sites and human observations:

- Is there correlation between instrumentation measurements of shade absolute values?
 - Is there correlation between instrumentation measurements of shade differences?
 - Is there correlation between trained human evaluators and instrumentation in determining acceptability?
- **Data Collection.** Spectrophotometer measurements were collected from 19 Government, fabric manufacturer, and spectrophotometer vendor sites. The sample set measured at each site contained 6 tile and 3 fabric samples to collect absolute value measurements. The samples also contained 2 additional fabric sets, each consisting of a single fabric “standard” and 18 other samples of the same fabric, which were used to collect the shade difference measurements. 10 trained human shade evaluators were used to review a set of 10 samples from 10 types of colored military fabric. Each evaluator assessed the acceptability (pass/fail) of the 10 samples from each fabric type based upon a fabric shade sample and fabric shade tolerances. Also, the human evaluators were allowed to provide comments on how the fabric compared to its shade standard.
- **Analysis.** The measurement data was analyzed using Statistical Package for the Social Science (SPSS) version 17. Also, linear graphical analysis, Analysis of Variance (ANOVA) and multivariate ordinary least squares (OLS) regression to conduct formal hypothesis testing.

Findings: The data show that there is significant statistical evidence that:

- a) There is correlation among shade instrumentation measurements of the absolute values for military fabric shades.
 - b) There is correlation among shade instrumentation measurements of shade difference between military fabrics.
 - c) For the fabric samples provided, spectrophotometers performed indistinguishably from human observer evaluations
 - d) There is correlation between instrument measurements and human/observer acceptance
- Other findings included
- There are differences in measurements from different sites and different spectrophotometer brands. This is suspected to be due to the high degree of precision in spectrophotometers.
 - Measurements tended to continue to decline with an increase in repeated reads of the Desert Sand fabric samples.

Current Status and Future Plans: With cooperation from Army Natick, the study results of the study have been assembled into a format for decision maker briefings. CDUM II will continue to support the efforts to improve shade production and evaluation, and support future efforts to develop the procedures to incorporate instrumentation measurements in shade acceptance and Government feedback processes.

6.0 Conclusion

6.1 Summary

The CDUM program from 2002-2009 focused on two areas: transition of functionality to the ARN production system and expanded demonstrations at two pilot sites. The overall objective of the program was to demonstrate advanced technology for the end-to-end supply chain management of hard-to-procure hard-to-manage items of the non-recruit clothing supply chain, specifically clothing and individual equipment. In addition to the specific results from each technology demonstration described in the previous section, the program illustrated the benefits of collaborative research with contributions from CDUM Partners, DSCP, DLA Program Management, C&T manufacturers, DSCP 3PLs, and Service clothing and equipment issue centers.

6.2 Lessons Learned

Each CDUM task resulted in specific R&D results. Collectively, all of the tasks in CDUM contributed to a more comprehensive understanding of the military clothing supply chain. Below is a distillation of the overall lessons learned under the CDUM program.

1. Data availability from master sources and using that data for pre-population is the foundation for consistent accuracy, supply chain visibility, and effective decisions.
2. Successful total supply chain visibility must start with 100% accuracy and completeness for manufacturer's shipment data and package identification documents and labels
3. Commercial RFID is an emergent technology. Significant technology adaptation and maturing was required to enable commercial RFID applications for military clothing.
4. Standardized inventory management software, processes, and documentation throughout the CIE supply chain are critical to achieve expedited replenishment and reduced inventory expenditures.
5. Interaction with legacy systems is essential for successful data collection and management, presents a significant challenge, and requires complete cooperation of the legacy system owner.

6.3 Business Case Analysis

The CDUM Business Case Analysis conducted in 2006 demonstrated that the benefits of the program based on retail and wholesale inventory cost avoidance are significant. The analysis predicted a positive net present value and return on investment.

Additional non-quantified benefits included: Improved asset visibility, accountability, and shelf-life management; Reduced item cost; Reduced operational cost from eliminating and streamlining of non-value-added processes; Improved data availability and accuracy; Improved readiness through increased availability of non-recruit clothing items; Improved assurance that serviceable assets are provided to the Warfighter, while non-serviceable assets are demilitarized and disposed of properly.

A separate analysis of the RFID initiative at Lackland AFB in 2009 demonstrated that inventory adjustments for those sites that do not utilize item level RFID tagging varied greatly from an aggregate of -.78% to 6.64% in comparison to LAFB's 0.2% inventory adjustment. On inventory levels at Lackland AFB that average \$12M this would represent adjustments of up to \$750K as opposed to the actual adjustment of \$24K.

6.4 Benefits

Other benefits from the CDUM program can be described as follows:

Industrial Base Impacts:

- Improved item tracking through the manufacturing process
- Significant efficiencies in packaging accountability
- More timely vendor payments
- Reduction in shipment errors and lost shipments

Supply Chain Manager Impacts:

- Precise asset visibility
- Improved demand planning
- Reduced inventory accountability errors
- Increased agility to move required assets
- More responsive industrial base
- Reduced safety stock levels
- Reduced out of stock condition and inventory shrinkage

Overall DoD Service Impacts:

- Reduction/Elimination of inventory adjustments and loss
- Reduction in inventory reconciliation time/resources
- Reduction in processing times/resources
- Improved asset accountability
- Reduced safety stock

Warfighter Benefits:

- Improved support from supply chain
- Improved availability of assets
- Immediate identification of location of defective/recalled assets

6.5 Future Initiatives

In 2009 the original CDUM program concluded. CDUM II will continue to pursue collaborative research in the following thrust areas:

1. Supply Chain Process Reengineering and Advanced Technology for Military Clothing – This effort will continue the Pilot at Lackland AFB. New areas include RFID for fabric manufacturers, improvement of 3PL effectiveness utilizing RFID and the exploration of implantable and high memory RFID tags for high-cost items.
2. Shared Asset Visibility and CIF Process Reengineering. This initiative will continue the Pilot at Ft. Carson CIF. New areas will include the development of automatic issuance guidelines through profiling and the further integration of Army and C&T data.
3. Manufacturing Methods for Product Performance and Quality Improvement – Work in the area of shade evaluation will continue through the exploration of shade development guidelines. New initiatives will

include improved technical data packages, improved fabric testing procedures, and an expansion of RFID demonstrations to the fabric supply chain.

7.0 APPENDICES

Appendix A – Definition of Terms & Acronyms

The following acronyms are used in this report and are provided for clarity of understanding for the reader.

- ◆ **3PL** – Third Party Logistics. CIE wholesale operation for C&T DSCP.
- ◆ **ABU** – Air Force Battle Uniform
- ◆ **AFCIIF** – Air Force Clothing Initial Issue Flight.
- ◆ **AIT** - Automatic Identification Technology
- ◆ **ARN** – Apparel Research Network made up of selected industry partners working together to develop innovative solutions for the Apparel industries support of military departments. The ARN system developed by this program transitioned to production. The successor R&D program is CDUM.
- ◆ **ASAP** – ARN Supply-chain Automated Processing
- ◆ **ASTRA** - ARN Supply-chain Transaction Repository Audit.
- ◆ **AAVS** – ARN Asset Visibility System
- ◆ **CDUM** – Customer Driven Uniform Manufacturing
- ◆ **C&T** – Clothing and Textiles Division of the Defense Supply Center Philadelphia.
- ◆ **CIE** – Clothing and Individual Equipment
- ◆ **CIF** – Central Issue Facility
- ◆ **CLINs** – Contract Line Item Number
- ◆ **DAASC** – Defense Automated Addressing System Center
- ◆ **DD250** – Material Receiving and Inspection Report
- ◆ **DCMA** – Defense Contract Management Agency
- ◆ **DFAS** – Defense Finance and Accounting Service
- ◆ **DLA** – Defense Logistics Agency
- ◆ **DSCP – Defense Supply Center Philadelphia** - DSCP controls the procurement and distribution of Medical, Subsistence (i.e., food), and Clothing and Textiles commodities to Defense Logistics Agency (DLA) depots and stock record accounts, worldwide.
- ◆ **EBS** – Enterprise Business System (Replaced SAMMS)
- ◆ **ESAPI** – Enhanced Small Arms Protective Inserts
- ◆ **HHT** – Hand-Held Terminal
- ◆ **IDOC** – Intermediate Document (formatted message from EBS)

- ◆ **IRM** – Integrated Retail Module
- ◆ **ISM** – Installation Support Module. ARMY's CIE inventory management system.
- ◆ **JSLIST** - Joint Service Lightweight Integrated Suit Technology
- ◆ **KYLOC** – Kentucky Logistics Operation Center. CIE inventory management and shipment to National Guard units.
- ◆ **LAFB** – Lackland Air Force Base
- ◆ **MRO** – Material Release Order
- ◆ **MSL** – Military Shipment Label
- ◆ **NSN** – National Stock Number
- ◆ **QAR** – Quality Assurance Representative
- ◆ **R & D** – Research and Development
- ◆ **RDO** – Redistribution Order
- ◆ **RFID** – Radio Frequency Identification. A technology that is a part of Automatic Identification Technology (AIT)
- ◆ **RTC** – Recruit Training Center (includes Army CIIPs) – These are the facilities operated by the different departments of the military where new recruits are inducted for basic training.
- ◆ **SAMMS** – Standard Accounting and Material Management System - This system was used by the Defense Logistics Agency, Defense Procurement Support Center prior to EBS.
- ◆ **TCN** – Transportation Control Number
- ◆ **VIM** – The Virtual Item Manager (VIM) system incorporates operational data extracted from the SAMMS Clothing & Textile (C&T) server as the basis for the operational and decision support capabilities provided in a single source of information for Item Managers at the retail (Recruit Training Centers) and wholesale (DSCP) level.
- ◆ **WAWF** - Wide Area Workflow (WAWF) is a secure Web-based system for electronic invoicing and acceptance.
- ◆ **WINS** – Web INvoicing System
- ◆ **WIP** – Work in Progress at the manufacturer.
- ◆ **XML** – Extensible Markup Language

Appendix B – ARN – CDUM Participants

PDIT Inc., dba Modulant. An ARN-CDUM Partner since 1997. The Technical Services Group of Government Services is located in Long Beach, CA, and primarily provides solutions to the DLA’s CDUM initiative. Modulant Technical Services delivers specialized solutions and services specifically targeted to support wholesale and manufacturing facets of total supply chain management.

AdvanTech, Inc. An ARN-CDUM Partner since 1997. AdvanTech, located in Annapolis, MD, provides DLA’s CDUM initiative with automatic identification and information technology solutions, and advanced logistics systems and processes to enhance supply chain management.

Logistics Management Institute (LMI). An ARN-CDUM advisor since 1994. A strategic consultancy committed to helping government leaders and managers reach decisions that make a difference. As a not-for-profit organization, it is a trusted advisor to government—free of commercial or political bias and dedicated to our mission of advancing government management.

Human Solutions of North America. An ARN-CDUM Partner since 1998. Human Solutions is the acknowledged ergonomics specialist company and world market leader in ergonomics simulation. Its Consulting & Services Division has provided ARN-CDUM 3D Whole Body Scanners and size prediction solutions for both recruit and non-recruit CIE.

DLA R&D. CDUM, as part of the DoD Manufacturing Technology (ManTech) Program, matures and validates emerging technologies to support low-risk implementation in industry and DoD facilities.

DSCP C&T. DSCP C&T, a primary level field activity of DLA, manages the procurement and distribution of clothing, textiles and equipment to military personnel worldwide. DSCP owns and manages the ARN system and provides proponent guidance to CDUM initiatives.

AFCIIF, LAFB. A CDUM R&D pilot site since 2002. As part of the 37th Training Wing, the AFCIIF acquires, manages, and issues recruit CIE, and is an active participant in using AIT and IT to expedite CIE movement and accountability in partnership with CDUM. It has also participated in the use of the 3D Whole Body Scanner for uniform size prediction.

CIF, Ft. Carson. A CDUM R&D pilot site since 2003. The CIF receives, stores, and maintains CIE for Fort Carson and the AR5-9 area of responsibility. The CIF has been active participant in AIT and IT to expedite CIE movement and accountability with CDUM. It has also participated in the use of the 3D Whole Body Scanner for uniform size prediction, and the interface of legacy systems to enhance the supply chain through the sharing of databases.

Travis 3PL. A CDUM R&D pilot site since 2005. Travis Association for the Blind, Austin, TX, otherwise known as the Austin Lighthouse, is a service oriented non-profit organization with the mission to assist people who are blind or vision impaired to attain the skills they need to become gainfully employed in the community. The 3PL or third party logistics provides wholesale services to DSCP C&T.

Warmkraft. A CDUM R&D pilot site. Warmkraft, Taylorsville, MS, is a manufacturer and finisher of Air Force Battle Dress Uniforms (ABUs) and other products. It was designated as a pilot for the CDUM Item Level RFID Pilot and Roll-Out Plan for RFID-tagging of Air Force items.

Propper International. A CDUM R&D pilot site. Propper International, Puerto Rico, is a manufacturer and finisher of Air Force Battle Dress Uniforms (ABUs). It was designated as a pilot for the CDUM Item Level RFID Pilot and Roll-Out Plan for RFID-tagging of Air Force items, and to determine alternative RFID solutions to that employed at Warmkraft.